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1 CLAIMS:

2 1. A chemical-mechanical polishing (CMP) method comprising:  
3 applying a solid abrasive material to a substrate;  
4 polishing the substrate with the abrasive material;  
5 flocculating at least a portion of the abrasive material on the  
6 substrate; and  
7 removing at least a majority portion of the flocculated portion of  
8 the abrasive material from the substrate.

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10 2. The CMP method of claim 1, wherein applying a solid  
11 abrasive material comprises applying a CMP slurry comprising  
12 substantially dispersed, solid abrasive material to the substrate and  
13 polishing the substrate comprises polishing the substrate with the slurry.

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15 3. The CMP method of claim 1, wherein applying a solid  
16 abrasive material comprises applying a polishing pad comprising solid  
17 abrasive material to the substrate and polishing the substrate comprises  
18 polishing the substrate with the pad.

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20 4. The CMP method of claim 1, wherein the abrasive material  
21 comprises ceria.  
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1 5. The CMP method of claim 1, wherein a temperature of the  
2 substrate during the flocculating does not exceed about 40 degrees  
3 Celsius (°C).

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5 6. The CMP method of claim 1, wherein the flocculating occurs  
6 after the polishing.

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8 7. The CMP method of claim 6, wherein the flocculating is  
9 performed on a secondary platen of a CMP tool.

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11 8. The CMP method of claim 6, wherein the flocculating is  
12 performed during spray action within a CMP tool.

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14 9. The CMP method of claim 6, wherein the flocculating is  
15 performed during immersion in an aqueous bath.

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17 10. The CMP method of claim 6, wherein the flocculating is  
18 performed in conjunction with polyvinyl alcohol brush scrubbing of the  
19 substrate.

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21 11. The CMP method of claim 6, wherein the flocculating is  
22 performed prior to cleaning by high-pressure spray action.  
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3 12. A CMP method comprising:  
4 applying a solid abrasive material to a substrate;  
5 polishing the substrate with the abrasive material;  
6 applying a surfactant comprising material to the substrate and  
7 flocculating at least a portion of the abrasive material with the surfactant  
8 comprising material;  
9 removing at least a majority portion of the flocculated portion of  
10 the abrasive material from the substrate.  
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12 13. The CMP method of claim 12, wherein applying a solid  
13 abrasive material comprises applying a CMP slurry comprising  
14 substantially dispersed, solid abrasive material to the substrate and  
15 polishing the substrate comprises polishing the substrate with the slurry.  
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17 14. The CMP method of claim 12, wherein applying a solid  
18 abrasive material comprises applying a polishing pad comprising solid  
19 abrasive material to the substrate and polishing the substrate comprises  
20 polishing the substrate with the pad.  
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1 15. The CMP method of claim 12, wherein the abrasive material  
2 comprises ceria.

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4 16. The CMP method of claim 6, wherein a concentration of the  
5 surfactant in the surfactant comprising material comprises about 10  
6 micrograms per milliliter ( $\mu\text{g/ml}$ ) to about 10,000  $\mu\text{g/ml}$ .

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8 17. The CMP method of claim 16, wherein the concentration  
9 comprises about 100  $\mu\text{g/ml}$  to about 1,000  $\mu\text{g/ml}$ .

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11 18. The CMP method of claim 12, wherein a temperature of the  
12 substrate during the flocculating does not exceed about 40 °C.

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14 19. The CMP method of claim 12, wherein the surfactant  
15 comprising material is applied after the polishing.

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17 20. The CMP method of claim 12, wherein the flocculating  
18 further comprises complexing at least a portion of the abrasive material  
19 with the surfactant.

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21 21. The CMP method of claim 12, wherein the surfactant  
22 comprises a cationic surfactant.  
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1 22. The CMP method of claim 21, wherein the cationic  
2 surfactant comprises a quaternary ammonium substituted salt.

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4 23. The CMP method of claim 22, wherein the quaternary  
5 ammonium substituted salt comprises a quaternary ammonium halide.

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7 24. The CMP method of claim 23, wherein the quaternary  
8 ammonium halide comprises a cetyltrimethylammonium bromide.

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10 25. The CMP method of claim 23, wherein the quaternary  
11 ammonium halide comprises a polyethoxylated quaternary ammonium  
12 halide.

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26. A CMP method comprising:  
applying a CMP slurry comprising substantially dispersed, solid  
abrasive material to a substrate;  
polishing the substrate with the slurry;  
applying to the substrate a surfactant comprising material that  
exhibits the characteristic of decreasing a settling time for the abrasive  
material in an aqueous dilution of the slurry;  
removing at least a majority portion of the abrasive from the  
substrate.

27. The CMP method of claim 26, wherein the abrasive material  
comprises ceria.

28. The CMP method of claim 26, wherein a temperature of the  
aqueous dilution does not exceed about 40 °C.

29. The CMP method of claim 26, wherein the surfactant  
comprising material is applied after the polishing.

30. The CMP method of claim 26, wherein complexing between  
at least a portion of the abrasive material and the surfactant forms  
flocule.

31. The CMP method of claim 26, wherein the surfactant comprises a cationic surfactant.

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32. A CMP method comprising:

- applying a CMP slurry comprising substantially dispersed, solid abrasive material to a substrate;
- polishing the substrate with the slurry;
- applying to the substrate a surfactant comprising material, wherein the surfactant exhibits a one-hour settling rate constant of greater than 0.035 for the abrasive material in an aqueous mixture of about 0.1 weight percent surfactant and about 1 weight percent slurry;
- removing at least a majority portion of the abrasive material from the substrate.

33. The CMP method of claim 32, wherein the abrasive material comprises ceria.

34. The CMP method of claim 32, wherein a temperature of the aqueous mixture does not exceed about 40 °C.

35. The CMP method of claim 32, wherein the settling rate constant is greater than about 0.09.



1           36. The CMP method of claim 32, wherein the surfactant  
2 comprising material is applied after the polishing.

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4           37. The CMP method of claim 32, wherein complexing between  
5 at least a portion of the abrasive material and the surfactant forms  
6 floccule.

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8           38. The CMP method of claim 32, wherein the surfactant  
9 comprises a cationic surfactant.

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39. A CMP method comprising:  
 applying a ceria-based solid abrasive material to a substrate;  
 polishing the substrate with the abrasive material;  
 applying a cationic surfactant comprising material to the substrate  
 and flocculating at least a portion of the abrasive material; and  
 removing at least a majority portion of the flocculated portion of  
 the abrasive material from the substrate.

40. The CMP method of claim 39, wherein applying a solid  
 abrasive material comprises applying a CMP slurry comprising  
 substantially dispersed, solid abrasive material to the substrate and  
 polishing the substrate comprises polishing the substrate with the slurry.

41. The CMP method of claim 39, wherein applying a solid  
 abrasive material comprises applying a polishing pad comprising solid  
 abrasive material to the substrate and polishing the substrate comprises  
 polishing the substrate with the pad.

42. The CMP method of claim 39, wherein a concentration of  
 the cationic surfactant in the surfactant comprising material comprises  
 about 10 micrograms per milliliter ( $\mu\text{g/ml}$ ) to about 10,000  $\mu\text{g/ml}$ .

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1 43. The CMP method of claim 42, wherein the concentration  
2 comprises about 100  $\mu\text{g/ml}$  to about 1,000  $\mu\text{g/ml}$ .

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4 44. The CMP method of claim 39, wherein a temperature of the  
5 substrate during the flocculating does not exceed about 40 °C.

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7 45. The CMP method of claim 39, wherein the surfactant  
8 comprising material is applied after the polishing.

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10 46. The CMP method of claim 39, wherein the flocculating  
11 further comprises complexing at least a portion of the abrasive material  
12 with the cationic surfactant.

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14 47. The CMP method of claim 39, wherein the cationic  
15 surfactant comprises a quaternary ammonium substituted salt.

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48. A CMP method comprising:  
applying a solid abrasive material to a substrate;  
polishing the substrate with the abrasive material;  
after polishing, brush scrubbing the substrate using a scrubbing  
solution comprising a surfactant material to flocculate and remove at  
least a majority portion of the abrasive material.

49. The CMP method of claim 48, wherein applying a solid  
abrasive material comprises applying a CMP slurry comprising  
substantially dispersed, solid abrasive material to the substrate and  
polishing the substrate comprises polishing the substrate with the slurry.

50. The CMP method of claim 48, wherein applying a solid  
abrasive material comprises applying a polishing pad comprising solid  
abrasive material to the substrate and polishing the substrate comprises  
polishing the substrate with the pad.

51. The CMP method of claim 48, wherein the abrasive material  
comprises ceria.

52. The CMP method of claim 48, wherein a temperature of the  
substrate during the flocculating does not exceed about 40 °C.



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1 56. A CMP method comprising:  
2 applying a solid abrasive material to a substrate;  
3 polishing the substrate with the abrasive material;  
4 after polishing, pressure spraying the substrate using a spray  
5 solution comprising a surfactant material to flocculate and remove at  
6 least a majority portion of the abrasive material.

8 57. The CMP method of claim 56, wherein applying a solid  
9 abrasive material comprises applying a CMP slurry comprising  
10 substantially dispersed, solid abrasive material to the substrate and  
11 polishing the substrate comprises polishing the substrate with the slurry.

13 58. The CMP method of claim 56, wherein applying a solid  
14 abrasive material comprises applying a polishing pad comprising solid  
15 abrasive material to the substrate and polishing the substrate comprises  
16 polishing the substrate with the pad.

18 59. The CMP method of claim 56, wherein the abrasive material  
19 comprises ceria.

21 60. The CMP method of claim 56, wherein a temperature of the  
22 substrate during the flocculating does not exceed about 40 °C.  
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1 61. The CMP method of claim 56, wherein the flocculating  
2 further comprises complexing at least a portion of the abrasive material  
3 with the surfactant material.  
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5 62. The CMP method of claim 56, wherein the surfactant  
6 material comprises a cationic surfactant.  
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8 63. The CMP method of claim 62, wherein the cationic  
9 surfactant comprises a quaternary ammonium substituted salt.  
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64. A CMP method comprising:  
applying a solid abrasive material to a substrate;  
primary polishing the substrate with the abrasive material;  
buffing the substrate along with applying a surfactant comprising  
material to the substrate and flocculating at least a portion of the  
abrasive material with the surfactant comprising material; and  
removing at least a majority portion of the flocculated portion of  
the abrasive material from the substrate.

65. The CMP method of claim 64, wherein applying a solid  
abrasive material comprises applying a CMP slurry comprising  
substantially dispersed, solid abrasive material to the substrate and  
polishing the substrate comprises polishing the substrate with the slurry.

66. The CMP method of claim 64, wherein applying a solid  
abrasive material comprises applying a polishing pad comprising solid  
abrasive material to the substrate and polishing the substrate comprises  
polishing the substrate with the pad.

67. The CMP method of claim 64, wherein the abrasive material  
comprises ceria.



1 68. The CMP method of claim 64, wherein a temperature of the  
2 substrate during the flocculating does not exceed about 40 °C.

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4 69. The CMP method of claim 64, wherein the flocculating  
5 further comprises complexing at least a portion of the abrasive material  
6 with the surfactant comprising material.

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8 70. The CMP method of claim 64, wherein the surfactant  
9 comprising material comprises a cationic surfactant.  
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